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While much of the world's attention is focused on outer space, encompassing a universe millions of miles in diameter, our attention is focussed on a globe scarcely one inch in diameter. To those of us in ophthalmic research, this minute cosmos has wonders of construction and function every bit as challenging as the mysteries of outer space; with aberrations quite as important to understand and rectify as those involved, for instance, in keeping a missile on course; and with a research yield much more satisfying for the time and money spent on it than that resulting from the development of weapons.

This Report is again the record of one year's attempt to learn more about the eye and its diseases, carried out by a dedicated staff at modest cost in comparison with today's research budgets.

Research Activities

Glaucoma. The vertical applanation tonometer; devised by Dr. Grant and described in last year's Report, has been subjected to further testing. A considerable number of measurements have been made on normal and glaucomatous adults with change in position from sitting to recumbency and the results compared with those of Schiötz tonometry and tonography on the same patients. It appears that change in intraocular pressure with change in position is not the same in all patients, indicating a need for closer examination of the influence of vascular pressures on intraocular pressure and of the relationship of applanation measurements to Schiötz tonometry. (Dr. Grant feels that tonography serves satisfactorily for diagnostic purposes without correction for abnormal scleral rigidity when the ratio Po/C is employed, since the numerator and denominator are influenced by variation in the rigidity in nearly proportional manner.)

Utilizing the same vertical applanation tonometer, a series of measurements have been made on the eyes of normal and glaucomatous infants and children. In some instances the pressure has been found to differ considerably from that indicated by the Schiötz tonometer. A greater number of comparisons will have to be made before it can be decided whether the frequency and amount of difference is of practical significance in a large number of cases, or whether it is found only in a certain variety of eye.

With the hope of discovering improved means for the medical treatment of glaucoma, a systematic investigation is being conducted on the influence of various enzymes on the outflow from enucleated human eyes. While several enzymes were found to be without effect, sufficient hope was raised by the effect of one enzyme in eyes obtained post-mortem that toxicity studies in rabbits and therapeutic trials in patients have been made. So far, the enzyme has been tolerated without unwanted reaction, but in patients the therapeutic influence has been irregular, seemingly helpful in some and not in others. More clinical trials are needed.

With an analogous hope of discovering improved means for the surgical treatment of glaucoma, aqueous perfusion studies have been conducted on a series of human eyes having glaucoma caused by peripheral anterior synechia. The resistance to outflow has been measured before and after lysis or separation of the synechias. It has been determined that such a maneuver is of little benefit to aqueous outflow once the synechias have become established but may be helpful within the first day or two of angle closure.

Finally, exploratory studies have been made utilizing an ultrasonic Oftalograf, attempting to detect and correlate anterior choroidal separation with degrees of hypotony and shallowing of the anterior chamber. So far this has been unsuccessful but with modifications it may be made to work.

Vascular Patterns of the Retina. By one of those circuitous routes that research often takes, the present studies on retinal vascular patterns evolved from seemingly unrelated observations on corneal lipogenesis. As noted in previous Reports, the corneal studies led to interest in atheromatosis and the studies on atheromatosis led to the present investigation of retinal vessels.

In comparison with the abundant literature on larger vessels, relatively little attention has been directed to pathologic changes at the capillary, arteriolar, and venular level. Perhaps there are few tissues in the body where this can be done as readily as in the retina. Dr. Kuwabara has developed a technique by which the nonvascular components of the retina may be digested away and the intact but isolated vascular tree is prepared as a flat mount. This provides a unique opportunity to study the smallest vessels with a variety of stains that reveal the vessel walls, the nuclei of the cells, and the associated structures. In addition to many animal retinas, approxi-

mately 200 human retinas have been studied to date by this method. These are making available new information about the vascular changes that occur with the aging process, with hypertension, with glaucoma, and with trauma. Plans for the future call for a study of diabetic changes in the retina and for a study of experimental vascular lesions. The results are expected to be as important for their systemic significance as for the local application to the eye.

Assisting Drs. Kuwabara and Cogan in these studies have been Dr. John Carroll, a Verhoeff Fellow for six months, and Dr. Daniel Toussaint, a NATO Fellow from Belgium.

Biochemical studies. Because of the universal interest in cataract formation, the lens of the eye has high priority in ophthalmic research. A long term investigation is being conducted by Dr. Kinoshita directed toward understanding some of the metabolic complexities of the lens. This past year special studies have been made of specific enzymes (dipeptidase, amino acid esterase, lactic dehydrogenase, and hexokinase) and of the interaction of enzymes for the utilization of glucose in the production of energy.

Contrary to popular opinion, the lens is far from being an inert tissue. Except for one reaction it has enzymes able to metabolize glucose readily. The rate limiting reaction is in the first step of glucose metabolism, the phosphorylation of glucose by the enzyme hexokinase. By removing this metabolic block the lens can be shown to be capable of utilizing glucose six times faster than its customary rate. Conversely, a slight decrease in hexokinase activity may severely curtail energy production in the lens.

The main component of lens is protein and a knowledge of proteolytic enzymes is also basic to understanding of structural turnover in the normal lens. Moreover, abnormal proteolysis is thought to be one of the pathogenic processes involved in cataract formation. Accordingly, Dr. Spector has been studying some of the enzymes believed to participate in protein metabolism in the lens. Although the demonstration of proteolytic enzymes in lenses offers special difficulties, he has isolated from calf lenses two active groups of enzymes, dipeptidases and amino acid esterases, and is currently working on methods for their purification.

To determine some of the aberrations in cataract formation, lenses have been studied after exposure to cataractogenic doses of microwaves. This study, carried out in conjunction with Dr. Russell L.

Carpenter of Tufts University, has shown that in this type of cataract the first biochemical change is a drop in ascorbic acid. This decrease in ascorbic acid level in the lens precedes the appearance of opacities and is not accompanied by measurable change in the ascorbic acid level of the aqueous humor or of the vitreous. Nor is there change in the glutathione level in the lens at a time when the ascorbic acid level falls. This observation is noteworthy since other forms of experimental cataracts, as those occurring with diabetes or following ionizing radiation, are said to show a drop in glutathione as the initial biochemical change.

Other biochemical studies have centered on the retina and the chemical processes involved in photosensitivity. The pigments of the retina which absorb light contain vitamin A aldehyde, or retinene, at their active center. The colorimetric method which has been in general use for determination of this aldehyde has had several serious drawbacks, including lack of specificity. In collaboration with Mr. Leonard D. Saslow of the Armed Forces Institute of Pathology, Dr. Futterman has developed a new analytic method which is sensitive, stable and specific for accurate determination of vitamin A aldehyde in tissue.

This new method has been used to localize the concentration of vitamin A aldehyde in the various portions of the retina. Homogenates of calf retinas have been separated into fractions consisting of nuclei, rod outer-segments, mitochondria, microsomes, and soluble protein constituents. The visual pigment rhodopsin (retinene and protein) has been found to account for 2 per cent of the dry weight of the dark-adapted calf retina. Moreover, retinene and the enzyme alcohol dehydrogenase, which reversibly transforms vitamin A into retinene, were found to be localized in the outer rod segments. Experiments are now in progress in which this method will be applied to understanding the relation between energy metabolism in the retina and the processes of light and dark adaptation.

The curious synthesis of fat by cells of the cornea, incubated in a medium containing serum and suitable fatty acids, has been a long term interest of this Laboratory. By use of a silicic acid column capable of fractionating 2 milligrams of lipid, Dr. Andrews has found the major product to be triglyceride. With isotopically labelled oleic acid or glucose as substrates, triglyceride was identified as the exclusive lipid end product. However, even when oleic acid was readily available, analysis indicated that palmitic and stearic

acid were also incorporated in the triglyceride; the origin of these additional fatty acids has not yet been clearly demonstrated.

Physiology. The technique, referred to in last year's Report, for the study of intraocular fluids by means of polyethylene tubes implanted into the anterior chamber, has been found satisfactory for prolonged observations on aqueous humor dynamics in animals. Dr. Kupfer plans to utilize this method to determine the influence of certain physiologic and pharmacologic variations on the intraocular pressure.

A modification of this technique in which the tubes are filled with saline solution and agar and then used as electrodes has permitted measurement of an electric potential across the living cornea. In conjunction with Dr. Ephraim Friedman of the Infirmary's Resident Staff, Dr. Kupfer has recorded a transcorneal potential averaging 20 millivolts, the anterior chamber being positive to the outer surface of the cornea. This potential was dependent upon an intact epithelium and was not affected by damage to other portions of the cornea. The potential measured in the living animal agrees with that recorded in excised cornea by other workers. So far no evidence has been forthcoming to support the suggestion that the transcorneal potential is involved in the maintenance of corneal deturgescence but further experiments are planned to study its possible relation to sodium transport across the cornea.

Study of the extraocular muscles has been pursued along quasi-clinical directions. Dr. Kupfer and Dr. Ingrid Gamstorp of the Neurology Service of the Massachusetts General Hospital have studied the electromyography of ocular muscles in patients with various conditions. In muscle palsies due to nerve lesions the duration of the action potential is appreciably increased whereas in primary muscle disease it is either normal or decreased. The measurement of duration appears to be a more reliable criterion of abnormality than simple measurement during contraction.

The enigma of color perception has intrigued Dr. Donaldson and his associates. With the aim of acquiring information on the rate with which different colors are perceived he has set up a device for estimating the relative time lag for perceiving colored objects. The test objects are presented on a rotating belt at various speeds. The findings confirm what has long been known in physiologic optics as the "fluttering heart" phenomenon but the aim of the

present investigators is to apply it and other color tests to persons with cerebral defects.

Retinal Metabolism. A study in localization of the retinal enzymes concerned with energy production has been one of the major projects of this Laboratory during the past two years. It came as no surprise to find that some of the enzymes, notably succinic acid dehydrogenase, were found predominantly in the mitochondrial-rich ellipsoids of the rods and cones. Indeed, this had already been apparent in reports of others. However, it was a surprise, as previously noted in these Reports, to find that other enzymes concerned with glucose utilization, for example lactic acid-DPN dehydrogenase, were concentrated in Müller's fibers of the retina. This was a surprise because Müller's fibers had been thought to have only a structural function in the retina. According to the present evidence Müller's fibers are inferred to be the chief sites for carbohydrate metabolism involving enzymes in the non-mitochondrial components of cytoplasm. We thus have in the retina a suggestive division of function whereby glycolytic and certain other enzymatic activities are maximal in some areas (Müller's fibers) whereas succinic and other mitochondrial-bound activities are maximal in other areas (ellipsoids of the rods and cones).

With the inference pointing to the participation of Müller's fibers for energy production in the retina and most particularly with the new information on the localization of enzymes concerned with glycolysis, it seemed expedient to reopen the question of distribution of glycogen in the retina. Glycogen is the storage form of carbohydrate fuels in the body. Its presence in the retina has been both affirmed and denied. No explanations have been advanced to account for the discrepancy in reports and no evidence has been presented heretofore to show the distribution of glycogen in the retina.

The glycogen studies have been rewarding. Some of the results were presented during the past year by Drs. Kuwabara and Cogan at the International Congress of Histochemistry. Not only was glycogen found to be present in the retina but it was localized almost exclusively in Müller's fibers. These fibers then take on the added significance not only for having the glycolytic enzymes but for being the reservoirs for the fuel on which these enzymes act. Moreover, synthesis of glycogen by these fibers could be demonstrated in vitro by appropriate incubation in the presence of glucose.

Müller's fibers are thus not merely storage bins for glycogen but factories for its formation as well.

Inconsistencies in the literature on retinal glycogen are probably attributable to considerable species variation. We have found the concentration of glycogen parallels approximately the blood supply. Those species which have poor blood supply and therefore no immediately available source of glucose have considerable stores of glycogen (rabbit and guinea pig), whereas those species with a rich blood supply (rat and cat) have relatively little glycogen. The human retina falls into this latter category.

Other aspects of retinal metabolism are cited elsewhere in this Report.

Neuro-ophthalmology. The association with neurologic interests in the Boston area, and most particularly with the Neurology Service at the Massachusetts General Hospital, continues to be a major source of satisfaction to Dr. Cogan and his associates. Of the several neuro-ophthalmic studies which came to fruition during the past year as a result of these contacts, one was an analysis of certain pupillary changes in ophthalmoplegia. Diabetic oculomotor paralysis appears to spare the pupil, unlike oculomotor palsies from other causes. A study was made on the clinico-pathologic findings in the eyes of patients with hydranencephaly. This, the first report of the condition in the ophthalmic literature, was a collaborative project of Drs. Kevin Hill of the Infirmary's resident staff, Dr. Cogan, and Dr. Philip Dodge of the Neurology Department. Another study consisted of an analysis by Dr. Cogan of the visual and para-visual symptoms in patients with parietal and temporal lobe lesions. This study constituted the Snell Lecture given at Rochester in April of this year.

Postmortem studies of the visual system were made by Dr. Kupfer, assisted during a summer fellowship by medical-student Saul Rosenthal, on the brains of patients who had had unusual neuro-ophthalmic lesions. Serial sections were prepared and compared with serial sections of brains from monkeys which had been subjected to experimental lesions. This latter portion of the project was a collaborative study with Dr. John Downer, formerly of the Harvard Medical School and now at University College, London.

Herpes simplex and toxoplasma. A special laboratory, having an

administrative connection with the Howe Laboratory, is currently in operation under the supervision of Dr. Herbert Kaufman. Its activities at present are devoted on the one hand to the study of the herpes simplex virus, a common cause of keratitis, and on the other hand, to a study of toxoplasmosis, a systemic disease that causes recurrent infection of the retina and choroid.

A test for the diagnosis and study of herpes simplex has been developed by which fluorescein-labelled antibody localizes in infected cells of a smear from the patient's cornea. This method appears as sensitive and much less cumbersome than present methods which depend on growth of the virus in living tissue.

A new test is also being developed for the diagnosis of toxoplasmosis. Red cells are being treated so that they will show a clumping when exposed to serum of patients with a high toxoplasmic antibody. It is hoped that this test will be simpler and safer than those now generally in use for the diagnosis of toxoplasmosis.

Corneal transplants. As soon as Barr and Bertram reported in 1949 a means for differentiating male and female somatic cells, it became evident to many of us that this technique might serve to answer the question of whether the cells of a transplanted cornea survive or are gradually replaced by the recipient. Initial attempts to identify the characteristic chromatin in female cells of the corneal stroma, however, failed. The stromal cells were too compact and their chromatin too sparse. But within the past few months Dr. Kuwabara has succeeded in developing a satisfactory technique by incubating excised corneal buttons in a manner similar to that previously employed for the study of corneal lipogenesis. The cells then swell to a degree that permits detection of the chromatin bodies and yet maintains the cells in situ to allow differentiation of host and donor tissue.

Currently Dr. Edward Sweebe is performing transplantation of cat corneas from one sex to another, and the results will be examined histologically at different times after surgery. Within the next year it should be possible to settle the old controversy as to whether the donor cells survive in corneal transplants or whether they are replaced by host cells. It may also be possible to ascertain the respective roles of the host and donor cells in the healing of transplant wounds.

Organization

Two major and several minor events of an organizational nature took place during the past year. One major event was the construction of additional laboratory space on the roof of the Out Patient Building and the other was the acquisition of an electron microscope.

The new space, made available by donations from the Lions Clubs of Massachusetts, the Public Health Service, the Infirmary, and private sources, has been designed for additional research and training facilities. It includes two large laboratory rooms and additional animal quarters. At present it serves for studies on lipid chemistry, neurophysiology and corneal transplantation. In the future it will provide accommodations in part for an expanded program of research training.

An electron microscope has now been finally acquired at the Howe Laboratory and was just put into operation at the end of the year. This will serve as an adjunct to morphologic studies already in operation at the Laboratory and will assist in the study of cellular subparticles whose properties are being studied biochemically. Further programs, contingent on obtaining additional staff personnel, are under discussion.

While not involving the Laboratory as a whole as much as one of us personally, some organizational changes have been brought about by Dr. Cogan's acceptance of the Chief Editorship of the *Archives of Ophthalmology*. Because of the unusual opportunity at the Howe Laboratory to have firsthand contact with both research and clinical problems it was thought wise to undertake the stewardship of the *Archives* at this critical period when researchers and clinicians tend to go their separately specialized ways. For the management of the *Archives*, Dr. Cogan fortunately has Mr. Perry Cunningham who carries much of the onus of the editorship and serves as a liaison with the American Medical Association under whose auspices the *Archives* is published.

Dr. Harold Kern, who has been a staff member of the Howe Laboratory for approximately a decade, resigned during the past year to become Research Biochemist at the Chronic Disease Research Institute in Buffalo, New York. He plans to continue the investigations in the ophthalmic field to which he has made so many valuable contributions.

We should also like to take note of Dr. Robert Trotter's appoint-

ment as Professor of Ophthalmology at the University of West Virginia. While Dr. Trotter has been attached to the clinical services of the Infirmary during the past several years, he was first a research fellow at the Howe Laboratory and, with Dr. Grant, effected the transfer of tonography from a research study to a clinical service, known at the Infirmary as the Glaucoma Consultation Service.

Service Activities

Service functions comprise a continuing commitment of the Laboratory. Aside from formal teaching in the postgraduate and undergraduate courses, a limited number of trainees are taken on in various departments of the Laboratory for varying times. Needless to say, this is a mutually beneficial service that introduces the trainee to research methods and often contributes substantially to the overall reaserch effort.

Three sets of stereoscopic atlases have previously been prepared by Dr. Donaldson dealing with neuro-ophthalmic anatomy, gonioscopy, and corneal dystrophies. These are sold at cost to teaching institutions, the transactions being handled by the Massachusetts Eye and Ear Infirmary. This past year a fourth atlas has been prepared by Dr. Donaldson assisted by Dr. Pinkerton, covering some ocular manifestations of systemic disease. At the same time the basic collection of more than 1500 stereophotographs is constantly being enlarged to make one of the finest ophthalmic teaching aids in the world. Fundus lesions can now be photographed readily by Dr. Donaldson's newly devised stereo-fundus camera and it may eventually be possible to have a collection featuring posterior ocular disease comparable to those now available for anterior ocular disease.

During the past year two persons spent summer fellowships in the Laboratory under the auspices of the Council to Combat Blindness. Dr. Robert Reinecke, one of these Fellows, concentrated on objective means of measuring visual acuity, a project with which he has had continuing interest since his previous studies in the Laboratory. Mr. Thomas Aaberg, a fourth year medical student, was also a Fellow under the same auspices; he spent his time with Dr. Kupfer in developing techniques for measurement of aqueous humor formation.

Two additional Fellows, sponsored by a training grant from the Public Health Service, were Dr. Jack Goldstein who spent six

months with Dr. Cogan in neuro-ophthalmology and Dr. Ronald Pinkerton who spent four months with Dr. Donaldson in preparation of teaching aids. Dr. Goldstein goes on to his residency at New York Eye and Ear Infirmary but Dr. Pinkerton, who has completed his residency at the Montreal General Hospital, plans to spend additional time at the Infirmary prior to his return to Montreal. Two additional Fellows, mentioned previously in this Report were Drs. John Carroll and Daniel Toussaint.

One of the problems in Dr. Donaldson's department has been to maintain a reasonable balance between service and research aspects in his photography. Attempts to set up a purely service photographic department at the Infirmary have not been successful. Many photographs, therefore, continue to be taken in the Laboratory which, however useful clinically, are not strictly research and which, in the aggregate, are costly. Fortunately, the Bausch and Lomb Company have agreed to underwrite some of these expenses for the present.

The Howe Library is, we are told, an example of what a specialized library should be. Being a part of the Infirmary and of the Harvard Medical School, it serves a wide group of clinicians, scholars, and investigators. This past year it has been possible to extend the Library's purchases in the field of the basic sciences owing to a liberalization of one of the Howe bequests which had been previously restricted to the purchase of historical material.

Support of the Laboratory

The income of the Laboratory's endowment provides approximately one-quarter of its expenses A large proportion of the rest comes from project grants which in the past year were provided by the Public Health Service, the Atomic Energy Commission, the United States Air Force, the Alfred P. Sloan Foundation, as well as training and research grants provided by the Verhoeff Fellowship, the Council to Combat Blindness, and the Public Health Service. Funds for construction of new laboratory space were provided chiefly by the Lions Clubs of Massachusetts, Public Health Service, and the Massachusetts Eye and Ear Infirmary.

These funds which in the aggregate amount to more than $100,000 annually are tremendously important and form the backbone of the Laboratory's continuing operation. But there are other

funds which, although less impressively large, are also extremely valuable. These are the funds given by the Knights Templar Eye Foundation, the David M. Whitney Fund, Research to Prevent Blindness, Inc. and private donors. Some of these latter donations are given as memorials; some are out-of-pocket expressions of gratitude for real or imagined services; some are prompted by a humanitarian desire to further the research on the eye and its diseases in a place where it is hoped it will do the most good. These donations are especially valuable because they are generally given without commitments. They are the gifts which permit us to make pilot investigations prior to formal applications for project support. This is pioneer money. It is a pleasure to announce as this Report goes to press that the Bausch and Lomb Company have graciously offered to contribute to this non-committed source of income.

Then there is another category of support, one that is perhaps of the greatest importance. These are the capital funds for endowment. These are the sources of income for not only this year's operation but for long term support and most especially to guarantee permanent posts for those capable investigators who wish to make a career of ophthalmic research. Having only limited contact with private patients and having no public relations representative other than ourselves, the Howe Laboratory staff has not been in a strong position to attract capital funds. We are confident, however, that such funds will eventually be made available through our many loyal friends. As noted in last year's Report the first of these capital additions, the Max, Martha and Alfred M. Stern Fund has been established and will be used for an additional tenure post in ophthalmic research.

It is scarcely necessary to reiterate our gratitude to those who have given so generously to the Howe Laboratory. Only by their benefactions has the work at the Howe Laboratory been possible this past year.

For general expenses:

Anonymous
Samuel T. Adams, M.D.
Henry F. Allen, M.D.
Mr. H. W. Baumgarten
William P. Beetham, M.D.
Mrs. Joseph H. Belair, in memoriam
Mr. Joseph H. Belair
Miss Jeanne Brou, in memoriam
Virgil G. Casten, M.D.
Paul A. Chandler, M.D.
Julian F. Chisholm, Jr., M.D.
Thomas G. Cogswell, M.D.
Z. William Colson, M.D.
Mrs. James Conger
Edward A. Cramton, M.D.
Thomas P. Cronin, M.D.
Dean Witter and Company
William F. Donoghue, M.D.
Edwin B. Dunphy, M.D.
Charles Dyson, M.D.
Mahlon T. Easton, M.D.
First Franklin Parking Corporation
Charles M. Foote, M.D.
The Gaylord Fund
Genradco Trust
Herbert Giller, M.D.
Miss H. Louise Harris
Mr. and Mrs. Harold L. Hazen
Kevin Hill, M.D.
Lawrence B. Holt, M.D.
John W. Irvine, Jr.
Carl C. Johnson, M.D.
Merrill J. King, M.D.
Mr. Robert Chandler Kinne, in memoriam
Brendan D. Leahey, M.D.
Mrs. Leon Levy
Mrs. Frederick H. Lovejoy
Massachusetts Eye and Ear Infirmary
Miss Jean McLean Morron
Henry A. Mosher, M.D.
Mrs. George M. Olive, in memoriam

The Pinettes
Marvin Posner, M.D.
Marion C. Putnam, M.D.
Research to Prevent Blindness, Inc.
Mr. John E. Rines, in memoriam
Mrs. David E. Rosengard
Baruch J. Sachs, M.D.
Benjamin Sachs, M.D.
David H. Scott, M.D.
Mrs. Anna P. Sears, in memoriam
Taylor R. Smith, M.D.
Mr. Paul Steiner
Max, Martha and Alfred M. Stern Fund
Mr. Sydney L. Stewart
Garrett L. Sullivan, M.D.
Fritz B. Talbot, M.D.
Mr. Frank J. Traversi
Mr. J. M. Ulmer
David M. Whitney Fund

For training purposes:
U.S. Public Health Service

For studies on tonography of the eye:
U.S. Public Health Service

For studies on toxicology of the eye:
U.S. Public Health Service

For studies on metabolism of the ocular lens:
U.S. Air Force
U.S. Atomic Energy Commission
U.S. Public Health Service

For studies on intra-ocular fluids and glaucoma:
The Alfred P. Sloan Foundation
Concordia Foundation

For studies on fat metabolism:
U.S. Public Health Service

We also wish to express our appreciation to the following technicians, secretaries, and other assistants who have collaborated with enthusiasm and persistence in the various studies carried out in the Howe Laboratory this past year: Patricia J. Aitken, Constance M.

Bailey, Inez M. Berry, Perry O. Cunningham, Elias Dikmak, Mary C. Keville, Elisabeth O. Lampert, Marcia C. Langenhagen, Irod Lindsey, Thomas Masurat, Werner Mueller, Jr., Louisa G. Murray, E. Joann Perkins, Gale H. Pierce, Josephine Roulusonis, Marjorie E. Saunders, Alexandra Wharton, and Billie-Louise G. Young.

DAVID G. COGAN, M.D.
Director

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Smith, J. L. with Mark, V. H. and Kjellberg, R. D.: Suprasellar epidermoid tumor. Neurol. *10*:81–83, January 1960.

Smith, J. L.: Some unusual motility problems of neuro-ophthalmological importance. Am. Orthoptic J. *10*:138–142, 1960.

Snyder, C.: A bibliography of the history of ophthalmology 1957 and 1958. A.M.A. Arch. Ophth. *63*:330–346, February 1960.

Spector, A.: Fractionation of calf-lens protein. Biochem. Biophys. Acta *38*: 191–192, February 1960.

Spector, A. with Ottesen, M.: A comparison of two proteinases from Bacillus subtilis. Compt. rend. trav. Lab. Carlsberg *32*:63–74, 1960.

LECTURES

ANDREWS, J. S.

Triglyceride formation in the cornea. American Chemical Society, in New York, New York, September 16, 1960.

COGAN, D. G.

Neuro-ophthalmology. Panel discussion, New York Academy of Medicine, Section on Ophthalmology, in New York, New York, January 18, 1960.

Midwinter Seminar in Ophthalmology and Otolaryngology, in Miami Beach, Florida, January 25–27, 1960:

Ophthalmologic errors that turn up in the pathology laboratory.

What the cornea and conjunctiva can tell us about systemic disease.

Syphilis and the eye. Dermatology Department, Massachusetts General Hospital, in Boston, Massachusetts, February 18, 1960.

The ocular fundus. Postgraduate Course in Cardiology, Massachusetts General Hospital, in Boston, Massachusetts, March 28, 1960.

Visual and paravisual symptoms of cerebral disease. Albert C. Snell Memorial Lecture, Rochester Ophthalmological Society, in Rochester, New York, April 14, 1960.

Neuro-ophthalmology. Third Year Medical Students, Harvard Medical School, in Boston, Massachusetts, April 19 and 21, 1960.

Blackouts. Alumni Association Meeting of the Massachusetts Eye and Ear Infirmary, in Boston, Massachusetts, April 26, 1960.

Visual and paravisual symptoms of cerebral disease. House Officer Lecture, Massachusetts Eye and Ear Infirmary, in Boston, Massachusetts, June 9, 1960.

Discussions, American Neurological Association, in Boston, Massachusetts, June 13, 1960:

Dual mechanisms of eye signs of headache in cluster pattern. Kunkle, E. C. and Anderson, B.

Congenital ocular motor apraxia. Menkes, J. and Altrocchi, P. H.

Ocular manifestations of metabolic disease. Postgraduate Course in Pediatrics, Harvard Medical School, in Boston, Massachusetts, June 16, 1960.

Histochemistry. Series of lectures to the Postgraduate Course in Ophthalmology, Harvard Medical School, in Boston, Massachusetts, September 30–October 14, 1960.

Neuro-ophthalmology. Postgraduate Course in Ophthalmology, Harvard Medical School, in Boston, Massachusetts, November 18, 22 and 29, 1960.

Some ophthalmologic aspects of endocrine disorders. Seminar, Basic Concepts in Clinical Endocrinology, Peter Bent Brigham Hospital, in Boston, Massachusetts, December 2, 1960.

Ophthalmic pathology. Department of Pathology, Harvard Medical School, in Boston, Massachusetts, December 17, 1960.

DONALDSON, D. D.

Postgraduate Course in Ophthalmology, Harvard Medical School, in Boston, Massachusetts:

Gonioscopy I. January 18, 1960.
Gonioscopy II. January 19, 1960.
Corneal dystrophy. January 22, 1960.

Syndromes with ocular involvement. U.S. Public Health Service Clinical Society, New England Branch, in Boston, Massachusetts, February 24, 1960.

Variations in corneal thickness. New England Ophthalmological Society, in Boston, Massachusetts, March 16, 1960.

Cause of edema in the cornea and its quantitative determination. Staff and House Officers of the University of Miami Medical School, in Miami, Florida, March 23, 1960.

Manifestations of allergy in the eye. New England Society of Allergy, in Boston, Massachusetts, March 30, 1960.

Third Year Medical Students, Harvard Medical School, in Boston, Massachusetts:

Neuro-ophthalmology, April 19, 1960.
Neuro-ophthalmology, April 21, 1960.
Ocular manifestations of metabolic and hereditary diseases, May 5, 1960.

Department of Postgraduate Medicine and Michigan State Medical Society, in Ann Arbor, Michigan:

Common neuro-ophthalmological disorders: Anatomical and clinical correlations. April 26, 1960.
The anterior segment and systemic disease. April 27, 1960.

Fundamentals of ocular therapeutics. Massachusetts General Hospital Pharmacy Staff, in Boston, Massachusetts, May 11, 1960.

Effect of ionizing radiation in the eye. Yankee Atomic Electrical Company Personnel, in Rowe, Massachusetts, May 21, 1960.

Industrial ophthalmology. Public Health Group, in Boston, Massachusetts, May 19 and 26, 1960.

Various conditions involving the angle of the anterior chamber. Postgraduate Glaucoma Course, Massachusetts Eye and Ear Infirmary, in Boston, Massachusetts, June 6, 1960.

Diseases of the anterior segment of the eye. Series of lectures to the Lancaster Courses in Ophthalmology, in Waterville, Maine, July 22–25, 1960.

Neuro-anatomy and anterior segment pathology. Series of lectures to the Postgraduate Course in Ophthalmology, Harvard Medical School, in Boston, Massachusetts, September 27–October 21, 1960.

House Officer Lectures, Massachusetts Eye and Ear Infirmary:

Conjunctival tumors and cysts. May 12, 1960.
Lid tumors. May 17, 1960.

Congenital defects. June 23, 1960.
Inflammatory conditions of the conjunctiva. June 28, 1960.
Inflammatory conditions of the cornea. July 28, 1960.
Congenital cataracts. September 22, 1960.
Cataract. September 27, 1960.
Corneal dystrophies I. November 29, 1960.
Corneal dystrophies II. December 13, 1960.

FUTTERMAN, S.

Biochemistry of the retina. Series of lectures to the Postgraduate Course in Ophthalmology, Harvard Medical School, in Boston, Massachusetts, September 29–October 14, 1960.

Retinal metabolism. Washington Pathology Club, in Washington, D.C., April 6, 1960.

GRANT, W. M.

Participation in Josiah Macy Jr. Foundation Conference Program, Fifth Symposium on Glaucoma, in Princeton, New Jersey, March 6–10, 1960.

Postgraduate Glaucoma Course, Massachusetts Eye and Ear Infirmary, in Boston, Massachusetts, June 6 and 10, 1960:
Ocular hydrodynamics
Gonio-anatomy
Pathology of glaucoma
Research in glaucoma.

Toxicology, tonometry and tonography. Series of lectures to the Lancaster Courses in Ophthalmology, in Waterville, Maine, August 25 and 26, 1960.

Experimental tonography. Symposium on Tonography, American Academy of Ophthalmology, in Chicago, Illinois, October 12, 1960.

Discussion: External filtering operations for glaucoma. A. Edward Maumenee. New England Ophthalmological Society, in Boston, Massachusetts, November 16, 1960.

Toxicology. Postgraduate Course in Ophthalmology, Harvard Medical School, in Boston, Massachusetts, October 17 and 21, 1960.

KINOSHITA, J. H.

Utilization of oxygen by the lens. Fifth Conference on Ophthalmic Biochemistry, in Dedham, Massachusetts, February 21, 1960.

Biochemical approaches to the study of cataracts. American College of Surgeons, in Boston, Massachusetts, February 29, 1960.

The effect of microwave radiation on the crystalline lens. Conference on the Biological Effects of Microwave Radiation, in Washington, D.C., March 25, 1960.

The effect of aging on the biochemical properties of the lens. International Congress of Gerontology, in San Francisco, California, August 11, 1960.

Biochemistry of the lens and cornea. Series of lectures to the Postgraduate Course in Ophthalmology, Harvard Medical School, in Boston, Massachusetts, September 30–October 14, 1960.

KUPFER, C.

Electro-oculography. New England Ophthalmological Society, in Boston, Massachusetts, January 20, 1960.

Motor innervation of extraocular muscle. Eastern Section of the Association for Research in Ophthalmology, in Philadelphia, Pennsylvania, February 18, 1960.

Physiology of the eye. Series of lectures, Department of Physiology, Harvard Medical School, in Boston, Massachusetts, April 4–6, 1960.

with Friedman, E.: Transcorneal potential in vivo. Wilmer Meeting, Johns Hopkins Hospital, in Baltimore, Maryland, April 8, 1960.

Ocular findings in diabetes. Series of lectures to the medical students, Harvard Medical School, in Boston, Massachusetts, April 26, 1960.

with Gamstorp, I: Electromyography of the eye muscles: Clinical applications. New England Ophthalmological Society, in Boston, Massachusetts, April 27, 1960.

Electromyography. House Officer lecture, Massachusetts Eye and Ear Infirmary, in Boston, Massachusetts, May 10, 1960.

Visual fields. Postgraduate Glaucoma Course, Massachusetts Eye and Ear Infirmary, in Boston, Massachusetts, June 7, 1960.

with Gamstorp, I.: Electromyography of eye muscles: Neurological applications. American Neurological Association, in Boston, Massachusetts, June 14, 1960.

Series of lectures to the Postgraduate Course in Ophthalmology, Harvard Medical School, in Boston, Massachusetts:

Aqueous dynamics. October 6, 14 and 18, 1960.
Electrophysiology. December 8, 1960.
Pathology of glaucoma. December 13, 1960.

KUWABARA, T.

Retinal dehydrogenase. Washington Pathology Club, in Washington, D.C., April 6, 1960.

Discussion: Retinal dehydrogenase. Symposium on Structure of the Eye, in New York, New York, April 11, 1960.

Cystinosis. Pediatric Seminar, Massachusetts General Hospital, in Boston, Massachusetts, June 3, 1960.

Retinal glycogen. First International Congress of Histochemistry, in Paris, France, August 31, 1960.

Histochemistry. Series of lectures to the Postgraduate Course in Ophthalmology, Harvard Medical School, in Boston, Massachusetts, September 30–October 14, 1960.

Oxidative enzymes. Dermatology Seminar, Massachusetts General Hospital, in Boston, Massachusetts, December 19, 1960.

MEROLA, L. O.

with Kinoshita, J. H.: The ascorbic acid content of rabbit eyes exposed to microwave radiation. Fouth Annual Tri-Service Conference on the Biological Effect of Microwaves, in New York, New York, August 16–18, 1960.

REINECKE, R. D.

Case report of migrainoid symptoms with cerebral anomalies. New England Ophthalmological Society, in Boston, Massachusetts, December 21, 1960.

SPECTOR, A.

Biochemistry of the lens. Series of lectures to the Postgraduate Course in Ophthalmology, Harvard Medical School, in Boston, Massachusetts, September 30–October 14, 1960.

FORM OF BEQUEST

The Howe Laboratory of Ophthalmology is an independent department of the Harvard Medical School and is jointly supported by a restricted endowment of Harvard University and by the Massachusetts Eye and Ear Infirmary.

For the information of those who may wish to contribute to this Laboratory, a form of bequest is here set forth:

I Give and Bequeath to the Howe Laboratory of Ophthalmology.....Dollars to be Applied to the Uses of Said Laboratory.

Such bequests are managed by the Treasurer's Office of Harvard University, and the income is accredited to the Laboratory.